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Eastern Pacific Expeditions of the New York Zoological Society. XVIII.

On the Post-embryonic Development of Brachyuran Crabs of the Genus *Ocypode.*[1]

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(Text-figures 1-8).

[This is the *nineteenth* of a series of papers dealing with the collections of the Eastern Pacific Expeditions of the New York Zoological Society made under the direction of William Beebe. The present paper is concerned principally with specimens taken on the Eastern Pacific *Zaca* (1937-1938) and *Arcturus* Oceanographic (1925) Expeditions. For data on localities, dates, dredges, etc., of these expeditions, refer to *Zoologica*, Vol. VIII, No. 1, pp. 1-45 (*Arcturus*), and *Zoologica*, Vol. XXIII, No. 14, pp. 287-298 (Eastern Pacific *Zaca*).]

CONTENTS.

I. INTRODUCTION.

The present paper is the first of a series dealing with the brachyuran crabs of the Eastern Pacific *Zaca* Expedition. It concerns the first zoea of *Ocypode gaudichaudii* and the megalopa of the two Pacific and single Atlantic species of the genus.

Previous reports on the Brachyura of the various Eastern Pacific Expeditions of the New York Zoological Society are the following: Rathbun, 1924, "Brachyuran Crabs Collected by the Williams Galápagos Expedition, 1923" (*Zoologica*, Vol. V, No. 14); Boone, 1927, "Galápagos Brachyura" (*Zoologica*, Vol. VIII, No. 4); Glassell, 1936, "Templeton Crocker Expedition. I. Six New Brachyuran Crabs from the Gulf of California" (*Zoo-*

[1] Contribution No. 591, Department of Tropical Research, New York Zoological Society.

logica, Vol. XXI, No. 17); Crane, 1937, "The Templeton Crocker Expedition. III. Brachygnathous Crabs from the Gulf of California and the West Coast of Lower California" (*Zoologica,* Vol. XXII, No. 3); Crane, 1937, "The Templeton Crocker Expedition. VI. Oxystomatous and Dromiaceous Crabs from the Gulf of California and the West Coast of Lower California" (*Zoologica,* Vol. XXII, No. 7).

The drawings in the present paper are the work of Miss Harriet Bennett.

To Mr. Templeton Crocker I wish to express my appreciation for the opportunity of collecting material on a cruise of his yacht *Zaca;* to Dr. William Beebe, Director of the Department of Tropical Research, for his supervision and advice in the preparation of this paper; and to Dr. Waldo L. Schmitt of the United States National Museum for the loan of specimens, and for his generous permission to dissect an Atlantic megalops and include the results of the study in this report.

II. Summary of Important Points.

1. The zoea of a species of *Ocypode* (*O. gaudichaudii* from the eastern Pacific) is described for the first time. It differs from that of the most closely related genus, *Uca,* principally in having lateral spines.

2. The megalopa of both eastern Pacific species of the genus, *O. gaudichaudii* and *O. occidentalis,* are described for the first time. They differ only in small details (such as the number of setae on the last pleopods) from the western Atlantic megalops, *O. albicans,* but are totally distinct from the known megalops of *Uca.*

3. The megalops described by Rathbun (1924, p. 155) as being perhaps referrable to *O. gaudichaudii* is shown to belong instead to the genus *Plagusia,* probably to *P. depressa tuberculata.*

4. A probable explanation of the peculiar characteristics of *Ocypode* megalopa is presented: Since a previous investigator (Smith, 1880) found evidence that *Ocypode* moults into the first crab stage in shallow holes on the exposed beach, the megalops must be washed in by the waves. Hence its obesity, its thick, hard cuticle, and its ability, through the development of special grooves, to fold all its appendages tightly against its body, serve as protections against the buffeting of the waves, scraping of the sand, and exposure to the drying effect of air in landing on the beach.

III. Previous Knowledge of Ocypodid Development.

A. Zoea: The zoeal stages of *Ocypode* have been hitherto unknown. Zoeae of a number of other ocypodids, however, have been identified: Those of *Uca pugilator* (Bosc), *U. pugnax* (Smith) and *U. minax* (Le Conte) have been described by Hyman (1920, pp. 485 ff.). Aikawa (1929, pp. 49-51) has described the first zoea of each of the following species: *Macrophthalmus dilatatus* de Haan, *M. japonicus* de Haan, *M. depressus* Ruppell, *Scopimera globosa* de Haan and *Ilyoplax pusillus* (de Haan). The same author (1937, p. 152) gives in tabular form a résumé of the principal characteristics of all the above species.

B. Megalops: Apparently only in the genera *Ocypode* and *Uca* have megalopa been described. In 1817 Say (p. 155 ff.) described as the type of a new genus and species *Monolepis inermis,* a strange creature which he referred to the Macroura near *Porcellana,* although he recognized and was puzzled by its resemblances to the Brachyura. Since the larval stages of crabs were, of course, quite unknown in those days, Say's conclusions were perfectly natural. In this, the first notice of its habits, he says: "Of this interesting animal I found several specimens on the eastern shore of Mary-

land, which had been cast on the beach by the refluent tide. They appeared desirous to protect themselves from the dashing of the surf, and the influence of the sun, by burrowing in the sand, in order to wait the return of the tide; but their efforts had no further effect on the compact sand, than to raise a small portion of the surface, which, by the action of the waves was spread over them so as to be distinguishable from the general surface by a small elevation."

Dana, in 1852 (p. 491) published the only figure of *M. inermis* up to the present time; with it, he described and figured a second species of *Monolepis, M. orientalis,* from the Philippines. It was not until 1873 that *Monolepis* was properly identified, when Smith (p. 67) set forth the opinion that *M. inermis* was the young of *M. albicans;* in 1880 (p. 25), he gave evidence, based on watching the actual moulting of a captured specimen taken in Vineyard Sound, that this theory was indubitably correct.

In 1924 Rathbun (p. 155) described a megalops from the Galápagos which she referred, with a question mark, to *O. gaudichaudii.* Boone in 1927 (p. 168) reproduced this description, and a photograph, of the same specimen. As I shall show later (p. 70), this Galápagos megalops should be referred instead to the genus *Plagusia.*

Lebour in 1932 (pp. 18-21) questionably referred two megalopa from the Philippines to this family; at least one of the specimens is certainly an *Ocypode* and the other doubtless belongs in the family if not in that genus (see p. 70).

Hyman (1920, pp. 496-497) has described the megalops of western Atlantic species of *Uca.*

IV. The First Zoea of *Ocypode gaudichaudii* Milne Edwards & Lucas.

(Text-figure 1).

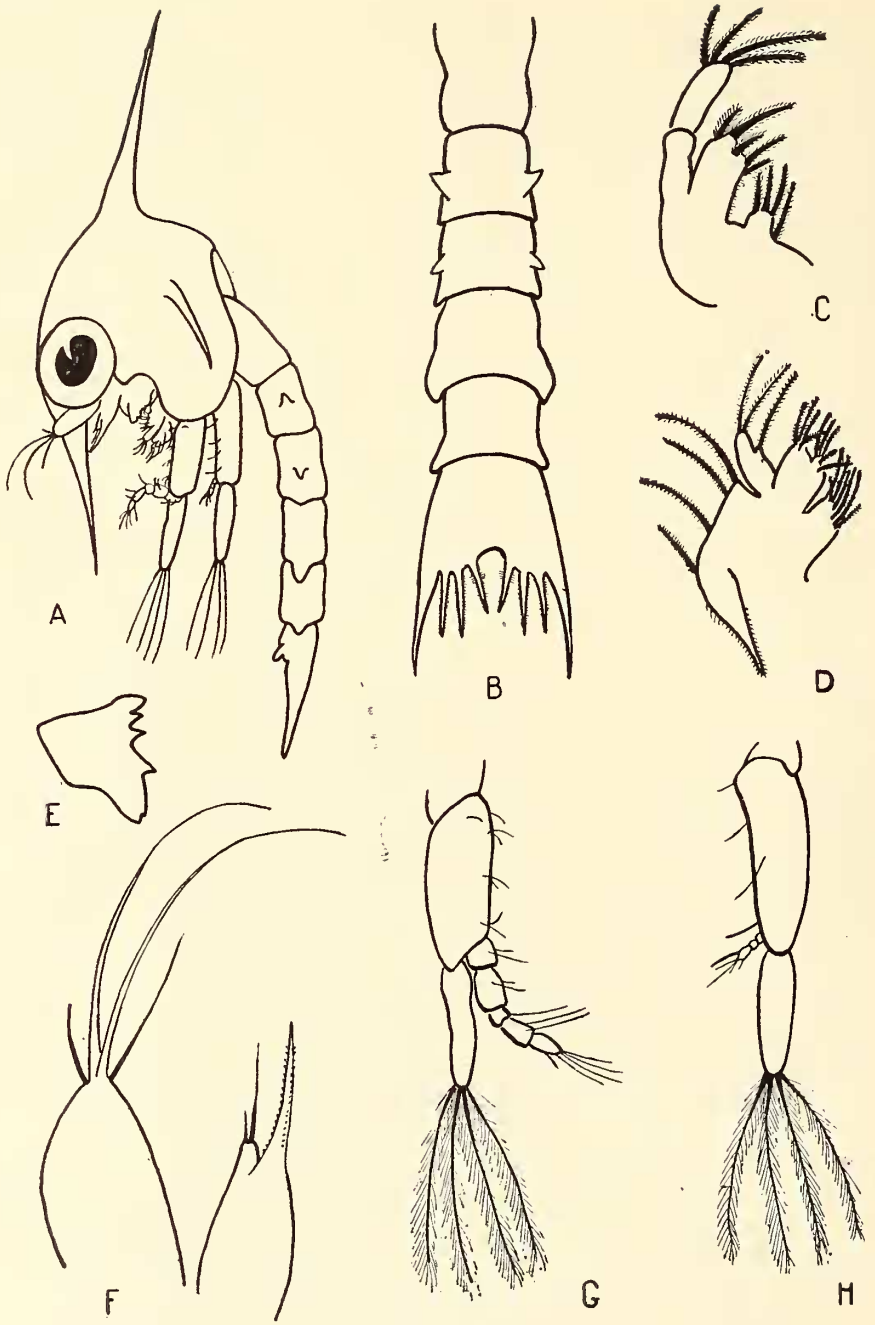
A. Material and Methods: A single ovigerous female was taken during the Eastern Pacific *Zaca* Expedition, at Bahia Honda, Panama, on March 15, 1938. The crab was kept in an aquarium with shallow water at one end and sand banked up at the other; it was fed bits of shrimp, mussel and fish. Most of its time was spent half submerged in the water. The eggs were well developed at time of capture, dark orange in color; they did not hatch, however, until 11 days later, on March 26. Unfortunately, the prezoea was not secured. The zoeae lived from 24 to 30 hours—no special attempt having been made to rear them—and were preserved in 70% alcohol. There was no difference between those killed as soon as it was discovered they had hatched, and those that died naturally the next day. They are catalogued in the collections of the Department of Tropical Research, New York Zoological Society, as Nos. 38,798 and 38,818.

In the following description, Aikawa's system of classification of antenna and telson, and his general methods of description, are used, though in amplified form (see Aikawa, 1929, 1933 and 1937).

B. Diagnosis: Dorsal, rostral and lateral spines present. Second antenna B-4 type. Telson B-type; hair formula: endopodite of first maxilla, 4-0; of second maxilla 2-1 (3) with a slight, unequal bifurcation; of second maxilliped, 5-0-0. Spines present on second and third abdominal somites.

C. Description: No primary chromatophores apparent (after 18 months in alcohol); almost all specimens lack even secondary chromatophores, pigment being completely absent except in the eyes.

The following measurements were made from specimens killed and preserved in 70% alcohol: Total length, from front to telson tip, *ca.* 1.6 mm; dorsal spine .54 mm.; rostral spine .43 mm.; perpendicular distance between their tips 1.47 mm.; lateral spine .23 mm.; abdomen 1.13 mm. long, .2 mm. wide (at fourth segment); telson .34 mm. long.



Text-figure 1.

Ocypode gaudichaudii: first zoea, total length (preserved in alcohol) 1.6 mm. **A**, lateral view; **B**, abdomen, dorsal view; **C**, first maxilla; **D**, second maxilla; **E**, mandible; **F**, antennule and antenna; **G**, first maxilliped; **H**, second maxilliped.

Postero-lateral region of carapace finely punctate. Dorsal and rostral spines moderately long, the dorsal the longer; dorsal straight, rostral slightly concave anteriorly; lateral spine a little more than half as long as rostral, curved strongly downward.

First antenna with 2 aesthetes and 2 unequal hairs on tip. Second antenna closest to Aikawa's B-4 type (1933, p. 126); much shorter than rostral spine but slightly longer than first antenna excluding terminal hairs; spinous process of peduncle thick with 2 longitudinal rows of serrations extending most of its length, but stopping short of the tip; about 17 serrations in each row; exopodite about one-fourth length of peduncle with a somewhat squared off tip giving rise to 2 unequal terminal hairs, the longer not reaching end of spinous process; flagellum rudimentary or absent.

Coxopodite of first maxilla with 4 hairs, basipodite with 5; endopodite 2-jointed, with 4 hairs on second, none on first segment. Second maxilla with 7 hairs on coxopodite, 9 on basipodite; endopodite with a slight, unequal bifurcation, 2 hairs on larger, distal part, and 1 on smaller, proximal part; scaphognathite with 4 hairs. Protopodite of first maxilliped with 2-2-2-2 hairs, of second with 1-1-1-1; endopodite of first maxilliped with 5-2-1-2-2 hairs, of second with 5-0-0.

Abdomen with six segments; a pair of small spines directed anteriorly on second segment, a similar pair directed posteriorly on third segment; fourth segment swollen laterally in posterior portion, the postero-lateral corners projecting backward over succeeding segment, but not actually spinous; corners of fifth segment similarly produced to a lesser extent. Telson B-type (i.e., with a normal, moderate fork, the horns being without spines); fork shallow, slightly more than half length of telson.

D. Comparison: The zoea of *Ocypode* differs from that of *Uca* as described by Hyman (1920) as follows: it is larger (at least 1.6 mm. long instead of not more than 1.0 mm.); lateral spines are present; the exopodite of the second antenna is shorter, with 2 unequal terminal hairs, instead of being long, with a short hair arising part way down its length[2]; the telson is less deeply forked; the endopodite of the second maxilla is slightly but noticeably bifurcated, the smaller, most basal lobe having 1 hair, the larger distal lobe 2 hairs, instead of there being 3 hairs on an unbifurcated tip. Chromatophore differences must be determined from fresh material.

If Aikawa's convincing suggestions as to the evolutionary value of the various characters be accepted, these differences lend support to his remarks on the relationships of the genera of Ocypodidae (1937, pp. 154-5), showing *Ocypode* as a more nearly direct link than *Uca* between the Macrophthalminae and Mictyrinae: While preserving the less specialized form of antenna and telsons found in the Macrophthalminae, it has lateral spines hitherto known in the family only in the Mictyrinae. However, certain knowledge of the relationships of this most interesting family must await a great deal of future study.

V. The Megalops of *Ocypode*.

(Text-figures 2-8).

A. Material and Methods: The present study of the megalops is based on the three American species, *O. albicans* Bosc, *O. gaudichaudii* Milne Edwards & Lucas and *O. occidentalis* Stimpson. The first ranges from Rhode Island to Brazil, the second from the Gulf of Fonseca, Salvador, to Chile, and the third from Lower California to Peru.

[2] This difference may prove to be slighter than it now appears, since Hyman was not certain whether one terminal hair continued the segment of the exopod: "The outer half of the tip of the basal portion bears the distal segment, which is small and cylindrical. From its tip arise two setae, one long, which seems to be a continuation of the segment, and a short, outer one." (Hyman, 1920, p. 491). If it is not a continuation, the antenna would be a B-4 instead of a B-2 type, according to Aikawa's classification (1933, pp. 126-7). There seems no doubt that the present specimens have two, distinct, terminal setae.

Megalopa of both Pacific species (here identified and described for the first time) are included in the collections of the Eastern Pacific Expeditions, as follows:

O. gaudichaudii, 8 specimens:

No. 25,205; Sta. 63 T-1; *Arcturus* Oceanographic Expedition; 20 mi. W. of Mariato Point, Panama (6° 58′ N. Lat., 81° 08′ W. Long.); night surface haul; May 11, 1925; 2 megalopa; carapace length[3] 4.72, 4.86 mm.; breadth 4.58 mm.; total length 5.43, 5.58 mm.

No. 38,112; Sta. 205 L-1; Eastern Pacific *Zaca* Expedition; Potrero Grande Bay, Costa Rica; night light; Jan. 23, 1938; 1 megalops; carapace length 5.58 mm.; breadth 4.72 mm.; total length 9.0 mm.

No. 38,823; Sta. 232 L-1 to L-4; Eastern Pacific *Zaca* Expedition; Gorgona Island, Colombia; night light; March 27-30, 1938; 5 megalopa; carapace lengths 4.86 to 5.72 mm.; breadths 4.3 to 4.86 mm.; total lengths 8.44 to 9.4 mm.

O. occidentalis, 2 specimens:

No. 37,160; Sta. 182 L-1; Eastern Pacific *Zaca* Expedition; Chamela Bay, Mexico; night light; Nov. 17, 1937; 1 megalops; carapace length 4.15 mm.; breadth 4.15 mm.; total length 7.43 mm.

No. 37,547a; Sta. 195 L-1; Eastern Pacific *Zaca* Expedition; Port Guatulco, Mexico; night light; Dec. 3, 1937; 1 megalops; carapace length 5 mm.; breadth 4.29 mm.; total length 7.7 mm.

Three megalopa of *O. albicans* from Woods Hole, Mass., were studied through the kindness of Dr. Waldo L. Schmitt (U. S. N. M. Nos. 10,995 and 11,175; carapace lengths 5.43 to 6.43 mm.; breadths 4.58 to 5.3 mm.; total lengths 8.15 to 9.58 mm.). Although the megalops of this species has long been known (see p. 000), it has never been adequately described and figured. Hence, illustrations of this form are included in the present report. Fortunately, one of these specimens has all the appendages tightly folded against the body, giving the clue for many of the peculiarities of form in the megalops of *Ocypode* (see below).

From a comparison of these three species, the well-marked generic characters of this stage of *Ocypode* become clearly evident. In spite of the similarity of the forms, drawings of the parts of all three are reproduced, as a basis for future work.

B. Taxonomy and Identification: As has already been remarked, (p. 67), *Monolepis inermis* has been identified without question as the megalops of *Ocypode albicans*. It is by analogy with this identification that Dana's very similar *M. orientalis* (1852, p. 491) and our own specimens are referred without question to *Ocypode*. Megalopa of the closely related genus *Uca* are, fortunately, very distinct, so that there is no question of confusion (see below, and Hyman, 1920, pp. 496-497 and figs).

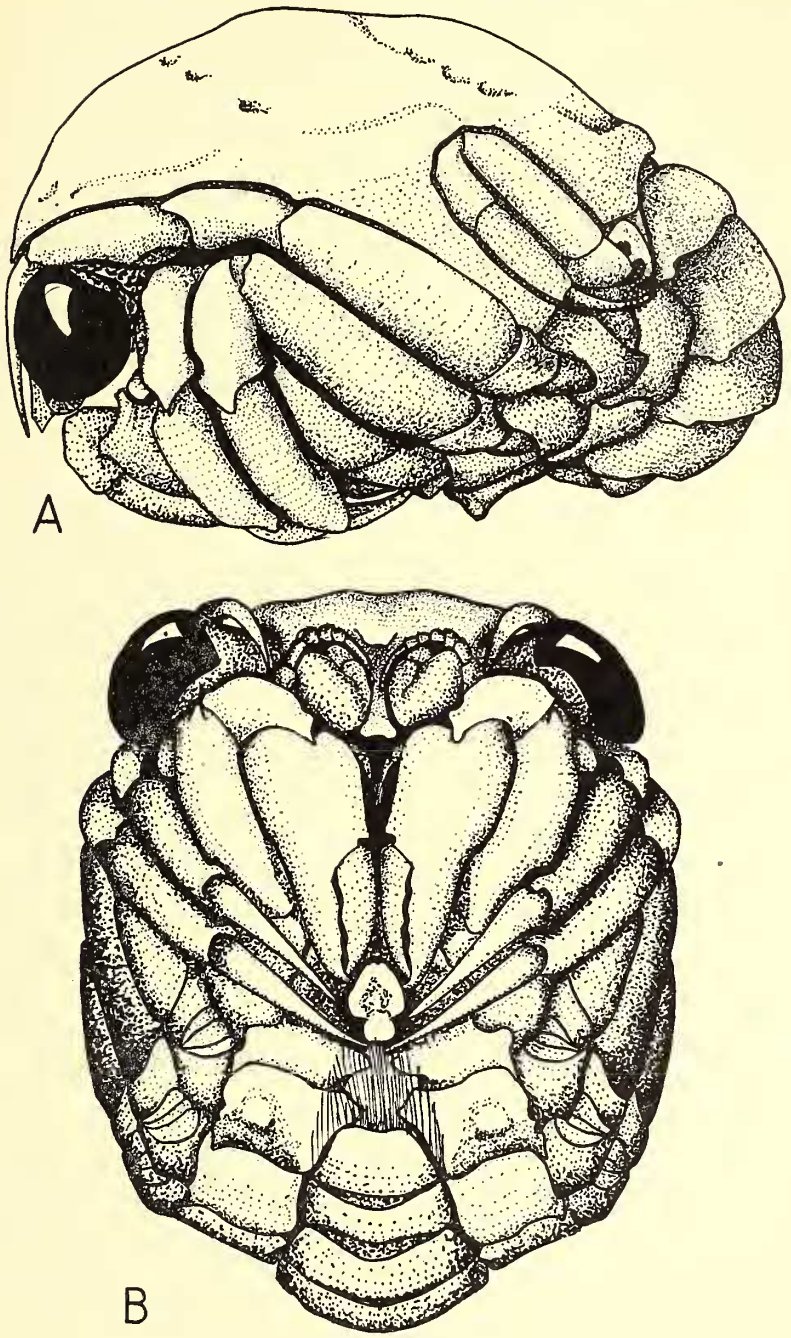
The megalopa questionably referred to Ocypodidae by Lebour (1932, pp. 18-21) are undoubtedly members of that family, although the genera cannot at the present time be settled. Her megalops A 1, 12 mm. long, with only seven hairs on the last pleopod and no hairs at the bases of the third and fourth legs, almost certainly does not belong to *Ocypode;* megalops A 2, on the other hand, will very likely prove to be a member of that genus.

A reexamination of the Galápagos megalops identified questionably as *O. gaudichaudii* by Rathbun in 1924, p. 155, shows that this specimen (U.S.N.M. No. 57,735) should be referred instead to the grapsid genus *Plagusia*, probably to *P. depressa tuberculata*, for the following reasons:

1. The spines on the tarsi are characteristic of grapsid, not ocypodid, megalopa.

2. The antennular fossae characteristic of the Plagusiinae are clearly marked, being more deeply incised in a straight dorsal view than the illustration indicates (*ibid.*, pl. VII, p. 154).

[3] Measured in median line.



Text-figure 2.

Ocypode albicans, megalops, showing position of appendages when folded against body. **A**, lateral view; **B**, ventral view. (From U. S. National Museum specimen No. 10,995; length of carapace in median line, 6.43 mm.).

3. The form of the maxillipeds is more similar to that of the adults of *Plagusa* than of *Ocypode*.

4. There are no hairs between the bases of the third and fourth legs. These are clearly apparent in true *Ocypode* megalopa.

5. Minor points such as the arrangement of hairs on the manus of the cheliped and on the carapace are typical of *Plagusia*, and especially of *P. depressa tuberculata*.

6. Finally, comparison with Aikawa's description and figures of *Plagusia dentipes* (1937, p. 136, fig. 36), and with *Percnon* megalopa in our own collections, show the close relationship in many similarities, while the thick cuticle, the exaggerated body depth and the sternal sculpturing which are so characteristic of true *Ocypode* are lacking.

The Pacific megalopa of the present collections, listed above, are divided without hesitation into the two Pacific species, *O. gaudichaudii* and *O. occidentalis*, since both specimens of the latter form were taken well north of the northern boundary of *O. gaudichaudii's* range, and exhibit distinct specific characters in the number of setae on the last pleopods and pattern of the sternal sculpture.

C. Comparison of *Uca* and *Ocypode*: The megalopa of *Ocypode* and *Uca* have in common the following characters, which seem to be of the most diagnostic value in determining families (see especially Lebour, 1928, pp. 488-491): Rostrum pointed, sharply bent, with a single median spine; no spines on carapace; 3 curved "feelers" on dactyls of fifth legs; more than 6 hairs on exopodites of last pleopods; hooks on basal segments of legs rudimentary or absent. In addition they have small, 10-11-segmented antennae; small chelipeds; external maxillipeds and other mouthparts of a general shape typical of adult Ocypodinae; and a tuft of hairs between the bases of the third and fourth legs, also as in the adults. There are no spines on the dactyls of the second, third and fourth legs.

Although present material is inadequate for a complete comparison, megalopa of these two genera may be distinguished by the following key. The characteristics of *Uca*, as given in the above paragraph and in the key, are taken from Hyman (1920, pp. 496-497).

A. More than 20 hairs on exopodite of last pleopod; anterior part of sternum conspicuously sculptured; no distinct bulge on inner margin of merus of third maxilliped; cuticle thick and hard; body excessively obese, almost cylindrical; carapace grooved for reception of appendages when folded ..... *Ocypode*

AA. Less than 15 hairs on exopodite of last pleopod; anterior part of sternum smooth; a distinct bulge on inner margin of merus of third maxilliped; cuticle not noticeably thick and hard; body not unusually obese, but instead flattened dorso-ventrally as is usual in megalopa; carapace not grooved for reception of appendages when folded ..... *Uca*

D. Generic Characters: The following description of *Ocypode* is based only on the three American species.

Diagnosis. Megalops large (total length up to 9.4 mm.), extremely obese[4], heavy, deeply pigmented, with thick, hard cuticle; rostrum small, vertical; sternum sculptured anteriorly, the pattern varying with the species; deeply grooved posteriorly for reception of the short abdomen; a prominent transverse, truncate, suborbital projection; chelipeds small; three curved "feelers" on tip of fifth leg; hooks on ischium of legs rudimentary or absent; a tuft of hairs present between bases of third and fourth legs; no spines on dactyls of walking legs; 22 to 28 setae on last pleopod.

Description. General color yellowish to dark brown with individual black chromatophores large and numerous or small and sparse, varying with the individual; carapace large, rounded dorsally, almost dome-shaped,

[4] Maximum body depth almost or quite equalling carapace width.

straight in front with small, three-pointed rostrum, the central spine longest, triangular, sharply bent, vertical in large specimens; two frontal eminences; frontal, gastric, cardiac and intestinal regions sometimes with pores, variously numbered and arranged, present or absent in individuals of the same species, possibly connected with moulting; a groove in the cardiac region, curving posteriorly, and a corresponding one in the intestinal curving anteriorly; both grooves varying slightly with the individual within the species; in the posterolateral region is a depression for the reception of the folded fifth leg.

Lateral region of carapace very deep, vertical, provided with shallow grooves for reception of the bent second, third and fourth legs. A prominent, rounded, horn-like projection extends sidewise from the suborbital region. Anterior sternal region sculptured with a prominent central knob, and various adjacent smaller projections, depressions and excavations, the pattern depending upon the species, and varying slightly with the individual; into and around this area fit the folded dactyls of the chelipeds and of the second and third legs. Sternal segments well marked, a projection on the one at the base of the second leg. Sternal groove deeply excavated for reception of the short, thick abdomen.

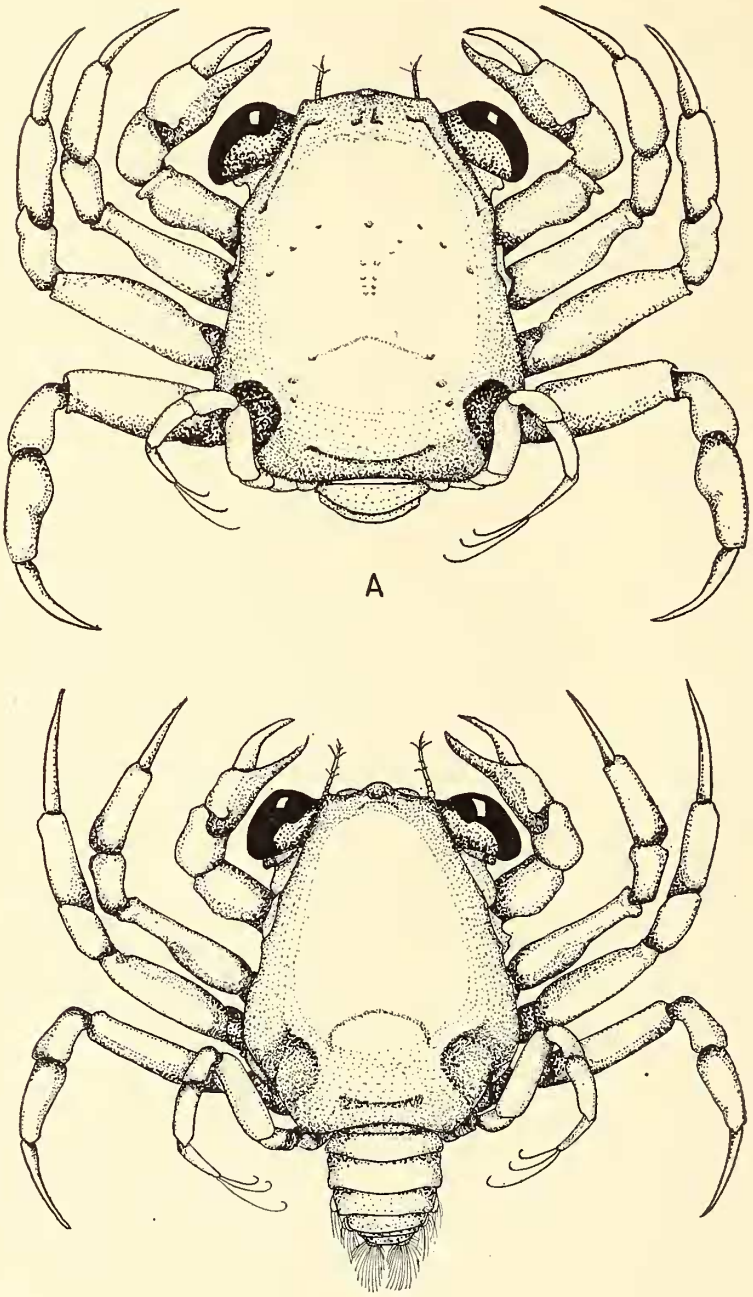
Antennule (Text-fig. 7 A-C) almost concealed, with a large, swollen basal segment containing a statocyst already well developed, and a five-jointed terminal process composed of the second to the sixth segments. A fringe of hairs makes a continuous line across the lower part of the basal segment and the upper part of the second, which arises from the inner, lower portion of the base. Anteriorly the base gives rise to two hairs. From the third segment arises a small, single-jointed external flagellum tipped with three or four hairs. The fourth, fifth and sixth segments bear about 6 to 10 long, sensory hairs each; in addition the sixth segment is tipped distally with a single stout hair. The antennule differs from that of the megalops of *Uca* (Hyman, 1920, p. 496, fig. 26) chiefly in the presence of an external flagellum, of three, not two segments in the terminal process, and of a fringe of hairs across the basal and second segments. In the adult *Ocypode* the basal segment is proportionally much larger, the external flagellum has two, not one, joints, and the terminal process is degenerate, almost lacking hairs and with only one segment apparent.

Antenna (Text-fig. 7 D-F) very short, similar to antenna of *Uca* in segmentation (*ibid.*, fig. 34), composed of three basal segments and a seven-jointed flagellum of which the fifth segment is longest (later to be divided into two, giving the 11 joints of the adult); a few sensory hairs at base of penultimate segment and a single distal hair; one to several hairs usually present on first two basal segments and third and fourth segments of flagellum. Because of the fragility of the antenna, an exact hair count and comparison of the three species studied is not possible with the present material.

Eyes moderately large, little projecting. Mandible (Text-fig. 7 G-I) similar to that of adult, with the cutting edge worn variously by use; palp three-jointed, as in adult and in *Uca*. Maxillae (Text-fig. 7 J, K) and maxillipeds (Text-fig. 8) similar to those of adult and of *Uca* (*ibid.*, figs. 51, 60, 68, 70, 74). First maxillae with very strong bristles on basal lobes, and a two-jointed palp. Epipodites large in first and third maxillipeds, moderate in second. No prominent bulge on inner edge of ischium of third maxillipeds, as there is in *Uca*, in both megalops and adult.

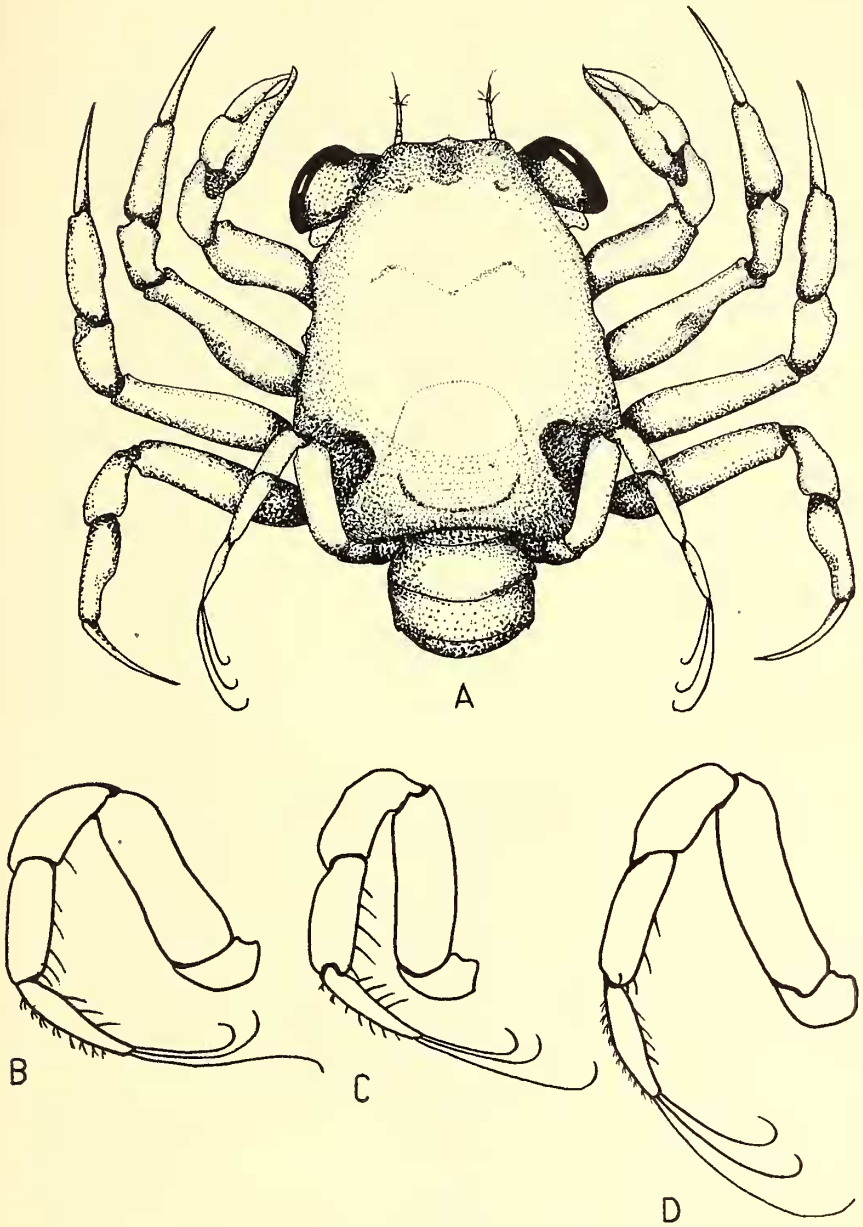
Chelipeds small, being short and only moderately broad and heavy.

Second, third and fourth legs small, fifth leg very small. All have various grooves, excavations and bulges on the segments which enable them to fit with extreme precision and tightness against the body and each other when folded: The chelipeds are held against the pterygostomium region, the second and third legs against the sides, each other and the sternum,



Text-figure 3.

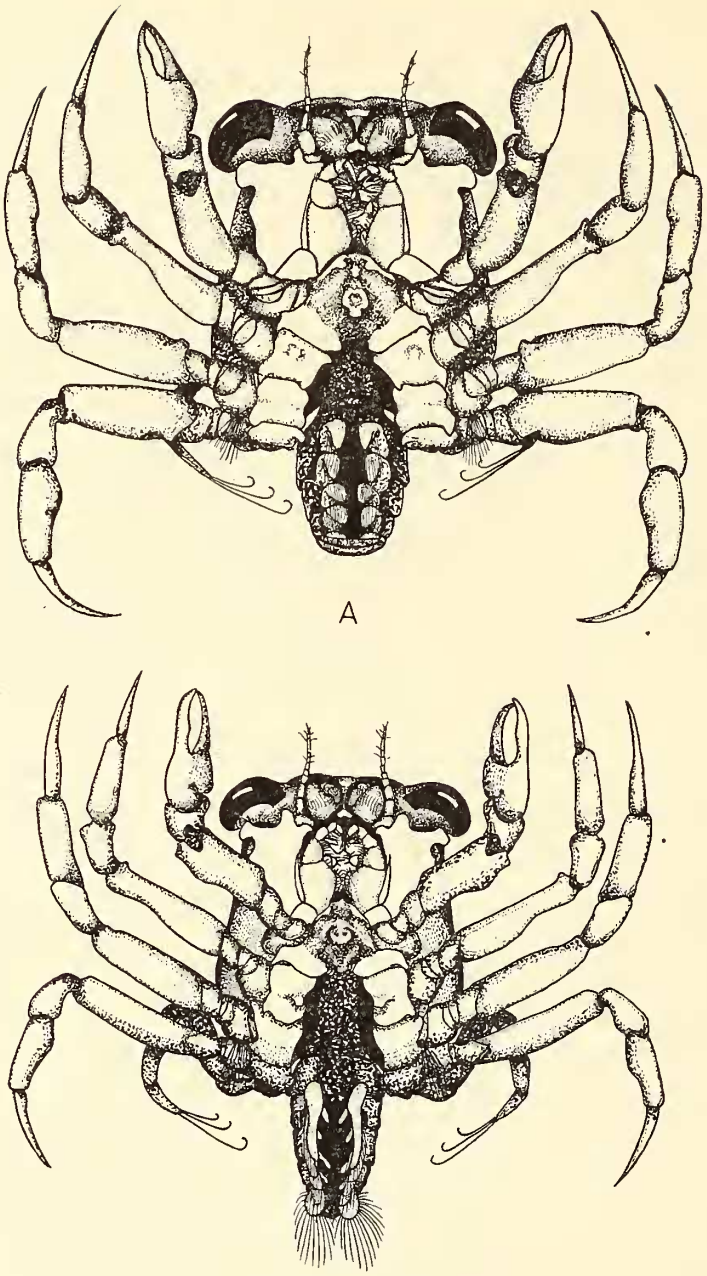
A, *Ocypode albicans;* **B**, *Ocypode occidentalis.* Dorsal view of megalopa, total lengths 8.15 and 7.43 mm. respectively. Short hairs on legs omitted.



Text-figure 4.

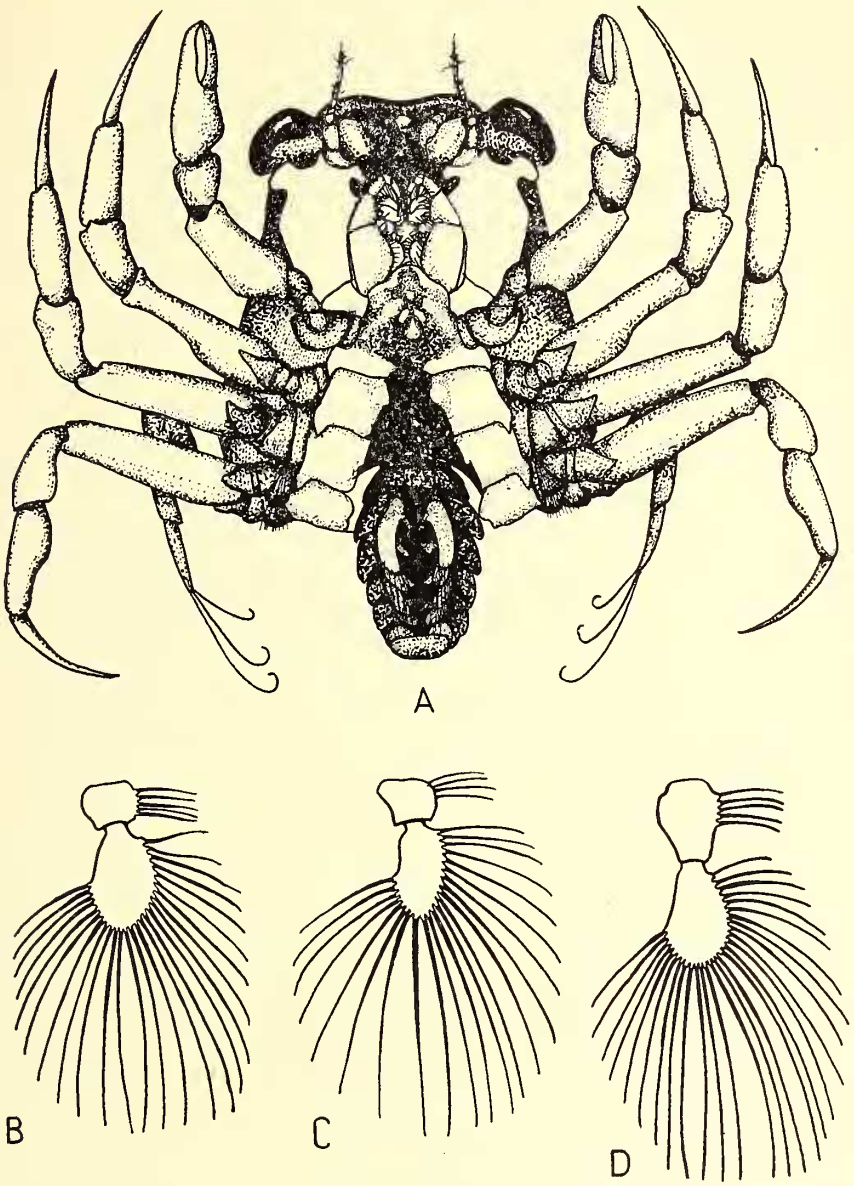
A, *Ocypode gaudichaudii*. Dorsal view of megalops, total length 8.6 mm. Short hairs on legs omitted. **B, C, D**, fifth legs of megalops of *O. albicans*, *O. occidentalis* and *O. gaudichaudii*, respectively, all drawn to same scale.

the fourth leg, which is the longest, straight forward with the dactyls hooking over the eye-stalk, and the tiny fifth legs exactly fitting into the posterolateral grooves. The few interstices left on the ventral surface of



Text-figure 5.

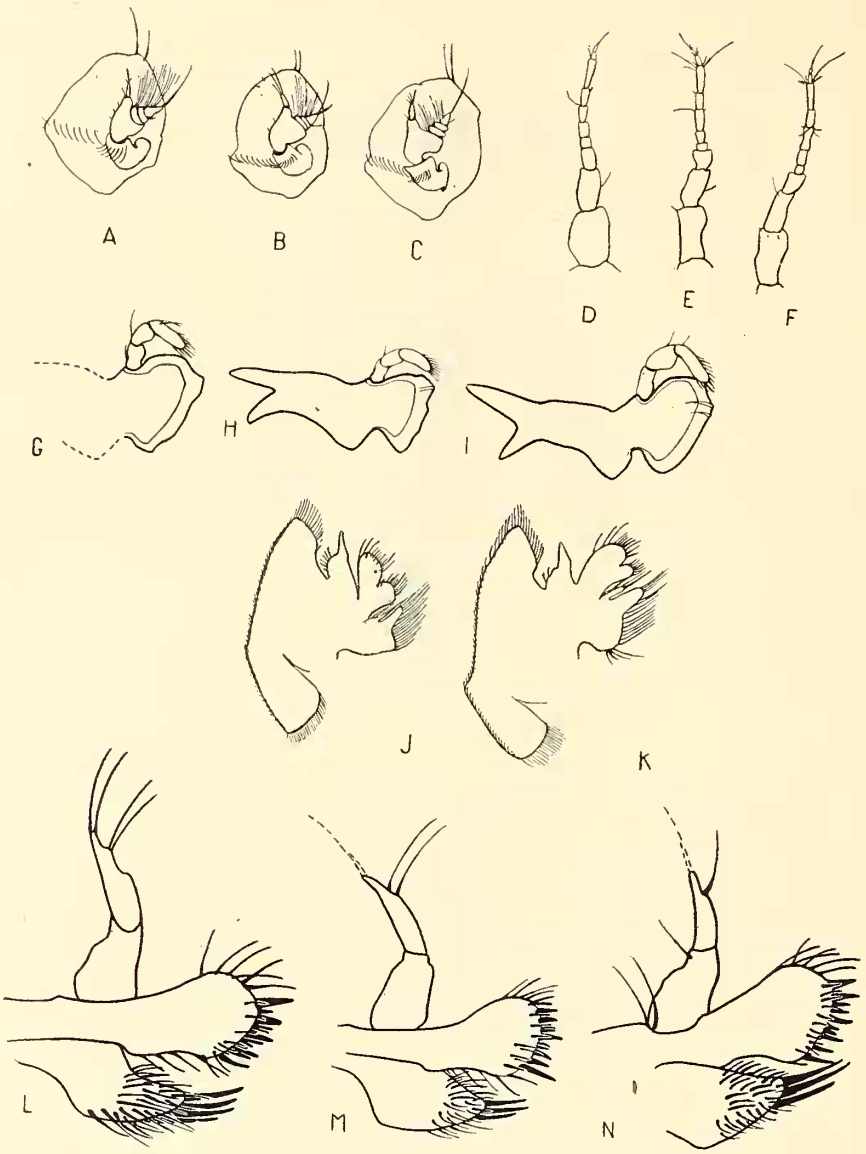
A, *Ocypode albicans;* **B**, *O. occidentalis.* Ventral views of megalopa in Text-fig. 3. Short hairs on legs omitted.



Text-figure 6.

A. *Ocypode gaudichaudii.* Ventral view of megalops in Text-fig. 4. Short hairs on legs omitted. **B, C, D,** exopodites of last pleopods of *O. albicans*, *O. occidentalis* and *O. gaudichaudii*, respectively, all drawn to same scale.

the megalops by the folded legs are exactly filled with the suborbital, epistomal and sternal projections. Hooks on ischia or meri rudimentary or absent (except in chelipeds of a Philippine specimen: see Lebour, 1934, p. 20, fig. 18).

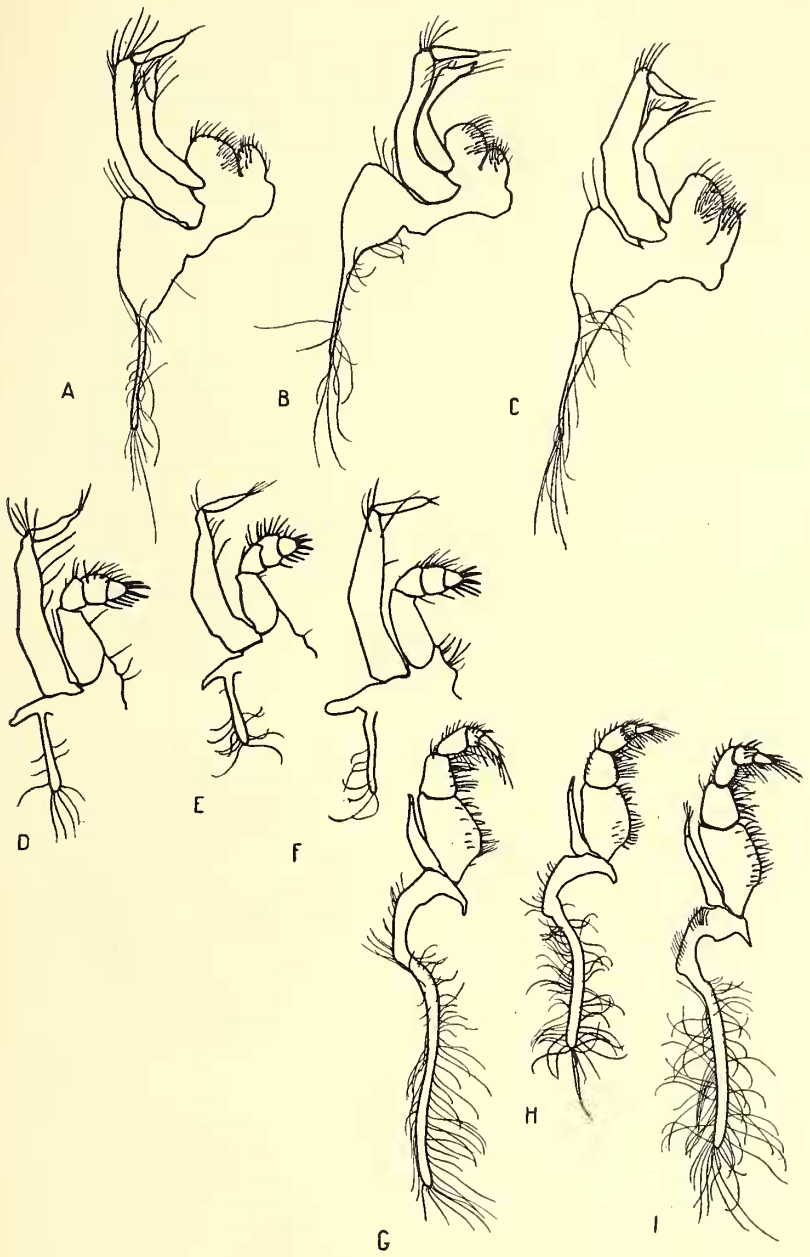


Text-figure 7.

Appendages of megalopa of *Ocypode*. **A, B, C,** antennule of *O. albicans*, *O. occidentalis* and *O. gaudichaudii*, respectively; **D, E, F,** antenna of *O. albicans*, *O. occidentalis* and *O. gaudichaudii*, respectively; **G, H, I,** mandible of *O. albicans*, *O. occidentalis* and *O. gaudichaudii*, respectively; **J, K,** second maxilla of *O. albicans*, and *O. gaudichaudii*, respectively; **L, M, N,** first maxilla of *O. albicans*, *O. occidentalis* and *O. gaudichaudii*, respectively. The corresponding parts of the three species are, in each group of drawings, drawn to the same scale.

A tuft of hairs present, as in the adult, between the bases of the third and fourth legs.

No spines on dactyls of second, third and fourth legs.



Text-figure 8.

Maxillipeds of megalopa of *Ocypode*. **A, B, C,** first maxilliped of *O. albicans*, *O. occidentalis* and *O. gaudichaudii*, respectively; **D, E, F,** second maxilliped of *O. albicans*, *O. occidentalis* and *O. gaudichaudii*, respectively; **G, H, I,** third maxilliped of *O. albicans*, *O. occidentalis* and *O. gaudichaudii*, respectively. All drawn to same scale. Number of hairs on epipodites approximate.

Fifth legs (Text-fig. 4 B-d) with three curved feelers on last segment. Last pleopods with 22 to 28 setae (Text-fig. 6 B-D). Telson rounded.

From the present material it is impossible to tell whether there are one or two megalopal stages, since none has been reared. Smaller examples within the species differ considerably from larger in minor details of carapace modeling, as well as in size, and it seems likely that unlike *Uca* (Hyman, 1920, pp. 496-497) there are two, not one. If this is so, then both specimens of *O. occidentalis* are doubtless in the first megalops stage.

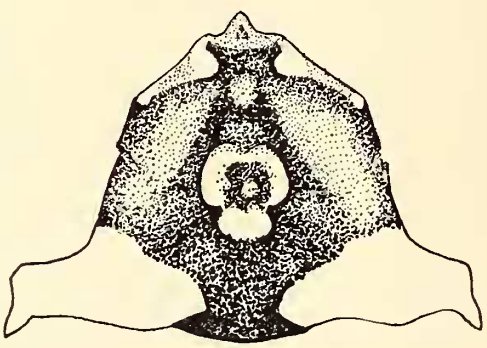
E. SPECIFIC CHARACTERS: Although, during this period, the three American species are so similar, there are two characters by which the forms may be easily differentiated: the number of setae on the exopodites of the last pleopods and the form of sculpturing on the anterior part of the sternum. These differences are best shown as follows:

O. occidentalis:

Anterior part of sternum as in fig.; 22 to 23 setae on last pleopods.

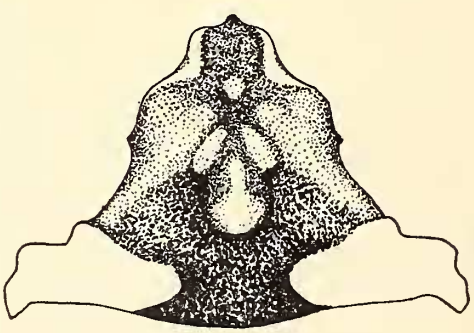
O. albicans:

Anterior part of sternum as in fig.; 26 to 28 setae on last pleopods.



O. gaudichaudii:

Anterior part of sternum as in fig.; 27 to 28 setae on last pleopods.



Minor differences are shown in the illustrations. The mouthparts are larger and hairier in *gaudichaudii* than in the other two species, as in the adults.

F. Ecology: The outstanding characteristics of the megalops of *Ocypode* are its obesity, the thickness of its cuticle and its provision for folding the appendages tightly against the body. These peculiarities are explained when the habits of the megalops are taken into account. The adult lives on beaches which are usually fully exposed to a heavy surf. The megalops described by Say (1817, the type of *Monolepis inermis*) and some of the specimens taken subsequently at Woods Hole by Smith (1873 and 1880) were taken on the beach, sometimes in the act of digging a rudimentary hole, apparently preparatory to moulting, or at least as protection from the waves. Thus it seems almost certain that the moult to the first crab stage takes place on the beach. If this is so, all the megalopal peculiarities named above are easily explained by the following theory: The thickness of the cuticle, the rotundity of form and the complicated arrangements for the folding of the appendages are all protections against the pounding of the surf and the scraping of sand in the shallows, as the megalops literally rides to shore on the crest of a wave. Were it fragile, with the appendages outspread, it would obviously lose most of the limbs and be battered in landing; also, it would run the risk of having the breathing apparatus clogged by the sand swirling at the edge of the tide. Afterwards, when the megalops has been left stranded, the thick cuticle helps conserve vital body moisture, and, if the megalops does actually, under normal circumstances, dig at this time, such hardness is obviously essential.

All of the specimens in the present collection were taken at night lights, usually just off shore; one, however, was captured twenty miles from the nearest land; in all probability such megalopa never reach a beach, and, of course, countless others must be washed up on rocky or otherwise uninhabitable coasts. Still others, as with New England examples of *O. albicans*, are carried by currents far out of their range, where the climate is so unsuitable that ultimate survival is impossible.

It will be interesting to learn whether other beach-dwelling ocypodids have similar adaptations, when their megalopa are discovered. Species of *Uca* which live in protected marshes and lagoons are not exposed to the same dangers in landing at the end of the megalopal stage; the lack of these specializations in Hyman's (*ibid.*) examples of *Uca* are apparent.

The stomachs of five megalopa (one of *occidentalis*, four of *gaudichaudii*) were examined and found to be completely empty except, in one case, for the remains of two minute crustaceans, apparently copepods.

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